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Effective control of ammonia loss in the manure collection pit of caged poultry layer system by coir pith application

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ABSTRACT : Poultry ownership provides a great opportunity for improved self resilience small scale agricultural sustainability through egg and meat production. The main issue of caged system poultry industry is managing the poultry droppings that build up in the manure collection pit beneath the cage. If not managed properly this waste material can create odour and attracts flies. Composted poultry droppings, on the other hand, can be an excellent resource for improving the soil health and fertility. During the storage of poultry droppings in the manure collection pit, huge quantity of nitrogen is lost in the form of ammonia. When composting a low C/N ratio material such as poultry droppings, it may be beneficial to add carbon instead of adding nitrogen which would boost the nitrogen immobilization and reduce volatilization. Adding a dry material with high carbon content in the manure collection pit periodically would reduce the moisture content of poultry droppings and temporarily immobilize the NH_4^+ by arresting the microbial activity for a short while. Keeping in view the present study was undertaken by applying dry coir pith into caged pit manure collection system to minimize the ammonia volatilization. Periodical application of coir pith into manure collection pit maintained the in-house ammonia concentration below 25 ppm which was 34 ppm at the beginning. After a period of three months, poultry droppings along with added coir pith were scraped out and allowed for composting and this compost found to be rich in N (2.08 %) with optimum C/N ratio 13.54:1.

KEY WORDS : Caged pit system, Poultry waste, Coir pith, Ammonia conservation

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INTRODUCTION

The quality of the air in and around the poultry house is directly related to birds' ability to respond to respiratory disease challenges and meet their genetic growth potential. Ammonia control is most important during the first 14-21 days of the bird's life, with the first 7 days being the most critical when chicks are most susceptible to ammonia damage. Birds exposed to ammonia during brooding have decreased resistance to Newcastle disease virus (Anderson *et al.*, 1964) and have more difficulty in clearing *E. coli* from the respiratory tract (Nagaraja *et al.*, 1984). While ammonia's effects are most evident during the first 21 days, the optimal ammonia level target is 25 PPM or less at all times to help fight off respiratory disease challenges and prevent weight loss. During grow-out, many producers rely on ventilation to prevent ammonia build-up. However, economic and management constraints often prevent sufficient ventilation, especially during winter months, causing increased ammonia exposure which dramatically affects flock performance. The problem is compounded as bird densities and reuse of litter increase and layout times decrease. Poultry house ammonia levels often range from 50 to over 200 ppm.

There are two types of confinement housing are

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commonly used for poultry operations 1. caged pit systems and 2. floor/ litter system. Caged pit systems are most commonly used for layer operations and consist of cages suspended above either deep or shallow pit. Manure from the birds falls into the pit and is removed periodically by scraping or flushing. Caged pit manure contains no bedding material and is normally semisolid or liquid in nature, depending on the type of removal system used. Floor systems are used for broiler and are normally single-storage house with an earth or concrete floor covered with 5 to 15 cm of a litter material such as sawdust, wood chips or other carbonaceous substances, which in turn decreases the incidence of disease and helps to maintain the bird's health. A good knowledge of the quality of poultry manure or litter produced on a farm or within a given geographic area is essential for the design of an effective waste management programme. Ammonia volatilization has long been considered as an important pathway for nitrogen loss during handling, storage and spreading of manure. Around 70 per cent of total nitrogen in fresh poultry manure is in the form of uric acid and urea and it will finally dissociate into gaseous form of ammonia and carbon-dioxide. Volatilization of ammonia during manure handling and storage reduces the agronomic value of the product and causes atmospheric pollution.

The N in poultry manure can be conserved by either inhibiting the hydrolysis of uric acid to NH_3 by reducing the volatilization loss of ammonia. Various chemicals such as formaldehyde and yucca saponin have been used to reduce uric acid hydrolyses, thereby conserving N in manure (Carlile, 1984). However, these chemicals are also found to affect nitrification and render the manure unsuitable for composting. Therefore, the best and easiest way to prevent NH_3 emissions from poultry droppings is to reduce microbial decomposition which can be accomplished by decreasing the moisture content of freshly produced droppings as soon as possible and keep the droppings under dry condition. In poultry, ammonia effects are seen from day one, so it is vital to choose a litter amendment that works immediately. Waiting a week for activation can cause irreversible damage. Keeping in view, the present study was undertaken in applying the dry coir pith in the caged poultry shed manure collection pit to keep the manure under dry condition throughout the poultry layer operation and reduce NH_3 emission.

MATERIAL AND METHODS

About 500 poultry chicks (30 days old) were used in this study. The poultry chicks were raised inside the rectangular iron cage which was placed above the rectangular pit (2 ft. in depth, 50 ft. length and 5 ft. breadth) for a period 3 months. A layer of about 15 cm of coir pith bed was formed in the manure collection pit just above the 5 cm river sand bed from the bottom of the concrete floor. The droppings were allowed to settle on the coir pith bed. The total quantity of droppings excreted by the birds was calculated. The C/N ratio of the poultry droppings was also calculated to quantify the quantity of coir pith to be applied in the manure collection pit so as to bring the C/N ratio of the mix in the pit between 25 to 30:1. Based on the C/N ratio, a known quantity of coir pith was spread over the fresh droppings in order to minimize the ammonia volatilization and thereby conserving the total N in the manure. Periodical samples were drawn from the pit and analyzed for various chemical properties by following standard methods and humification index by the method reported by Sequi *et al*. (1986). After three months, the partially decomposed mixes of poultry droppings and coir pith from the manure collection pit were scrapped out, transported to compost yard and allowed for composting for about 6 weeks. Udaipur low grade Rock phosphate was added @ 2.5 kg per 100 kg of compost mix for nutrient enrichment.

RESULTS AND DISCUSSION

The loss of ammonia to the atmosphere causes a loss of nitrogen and significant deleterious effects on forest, lakes and natural resorts (Bak *et al.*, 1999). Therefore, there is increasing interest in technology that will reduce NH_3 emissions arising from field application of livestock manure (Martin *et al.*, 2003). The initial pH and EC of the poultry droppings was 6.3 and 3.21 dSm^{-1}, respectively. The carbon and total nitrogen content of the poultry droppings were 44.06 and 3.02 per cent, respectively (Table 1). About 70 kg of poultry droppings were excreted by 500 birds in one day. Dry coir pith (105 kg) was spread over the droppings in the morning hours and evening hours after collecting the eggs. The calculated quantity of dry powdered coir pith (735 kg per week) was spread over the poultry droppings (490 kg in a week) for about three months regularly. Samples were taken from the mixes and analyzed for various chemical parameters. The pH of the mix (poultry droppings and coir pith) was 6.70 and EC was 1.81 dS m^{-1}, respectively.

The periodical change in chemical properties of poultry droppings in the caged system manure collection pit was recorded during the application of coir pith. Initial carbon content was 41.80 and the total nitrogen 1.59 per cent (Table 1). The C/N ratio of the mix in the manure collection pit was 26.18 during the initial period and the

Table 1 : Characteristics of poultry droppings and coir pith added poultry droppings

	Poultry droppings	Poultry droppings + coir pith	Composted poultry droppings + coir pith
pH	6.30	6.70	7.92
EC (dS m^{-1})	3.21	1.81	1.83
Total carbon (%)	44.06	41.80	28.17
Total N (%)	4.02	1.59	2.08
Total P (%)	1.42	1.49	2.61
Total K (%)	2.04	2.12	2.94
C/N ratio	10.96	26.29	13.54

Table 2 : Effective control of ammonia loss by coir pith application in the manure collection pit of caged layer system

Day (Pit)	Quantity of poultry dropping excreted (kg) (500 Birds)	Poultry droppings : coir pith application Ratio	Quantity of coir pith applied (kg)	Cumulative poultry droppings excreted (kg)	Cumulative coir pith applied (kg)	Changes in carbon (%)	Changes in total nitrogen (%)	C/N ratio*	NH_3 conc. in the shed (ppm)
1	70	1:1.50	105.0	70	105.0	41.8	1.59	26.18:1	4
7	490	1:1.50	735.0	560	840.0	42.3	1.75	24.12:1	13
14	490	1:1.50	735.0	1050	1575.0	42.7	1.57	27.12:1	22
21	490	1:1.25	612.5	1540	2187.5	42.1	1.61	26.16:1	34
28	490	1:1.25	612.5	2030	2800.0	43.2	1.61	26.89:1	26
35	490	1:1.00	490.0	2520	3290.0	43.0	1.65	26.12:1	22
42	490	1:1.00	490.0	3010	3780.0	42.9	1.69	25.42:1	13
49	490	1:0.75	367.5	3500	4147.5	41.8	1.78	24.02:1	16
56	490	1:0.75	367.5	3990	4515.0	41.0	1.75	23.62:1	14
63	490	1:0.50	245.0	4480	4760.0	39.7	1.78	23.01:1	18
70	490	1:0.50	245.0	4970	5005.0	39.5	1.80	22.06:1	16
77	490	1:0.25	122.5	5460	5127.5	39.5	1.81	21.82:1	16
84	490	1:0.25	122.5	5950	5250.0	39.1	1.85	21.16:1	14
91	490	-	-	6390	5250.0	37.6	1.87	20.12:1	12

* C/N ratio of the compost mix collected from manure collection pit of caged layer system

Table 3 : Changes in C/N ratio and maturity index of the coir based poultry wastes compost under Pit-Land composting method

Day (Land)	Total carbon (%)	Total nitrogen (%)	C/N ratio*	Humic acid (%)	Fulvic acid (%)	Humification index
1	37.62	1.87	20.12	-	-	-
7	36.12	1.90	19.01	-	-	-
14	34.59	1.92	17.83	35	59	0.04
21	34.02	1.96	17.35	46	60	0.77
28	32.16	1.99	16.16	61	58	1.05
35	28.19	2.06	13.66	52	26	2.00
42	28.17	2.08	13.54	73	18	4.05

*Data collected after the poultry dropping +coir pith transferred from the manure collection pit of caged layer system to compost yard

C/N ratio was maintained in the range of 25-30:1 by applying coir pith in the manure pit. The periodical observations of C/N ratio of the mix in the manure pit showed a ranged from 27.12 to 20.12 during the entire period of 3 months. The uric acid and urea are rapidly hydrolyzed to NH_3 and CO_2 by the enzymes urease and uricase if temperature, pH and moisture are adequate for microbial acitivity (Siegel *et al.*, 1975). Ammonia concentration in the poultry shed ambient air was reduced from 34 ppm to 12 ppm (Table 2). Then the mix was shifted to compost yard for making compost. This mix had a carbon content of 37.62 per cent, total N 1.87 per cent and C/N radio 20.12. Rock phosphate was added to the mix for enrichment. The carbon content of the mix showed a declining trend of 37.62 to 28.17 per cent and the total N content showed an increasing trend of 1.87 to 2.08 per cent. The C/N ratio to the mix reduced (20.12 to 13.54) as the composting period advanced. The humic acid content of the compost mix was increased from 35 to 73 and while the fulvic acid content was reduced (Table 3).

Periodical application of coir pith in to the manure collection pit of caged poultry system reduced the flies and odour problem. Also the application of coir pith maintained the ammonia concentration below 25 ppm in the poultry shed which was 34 ppm before the application of coir pith.

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